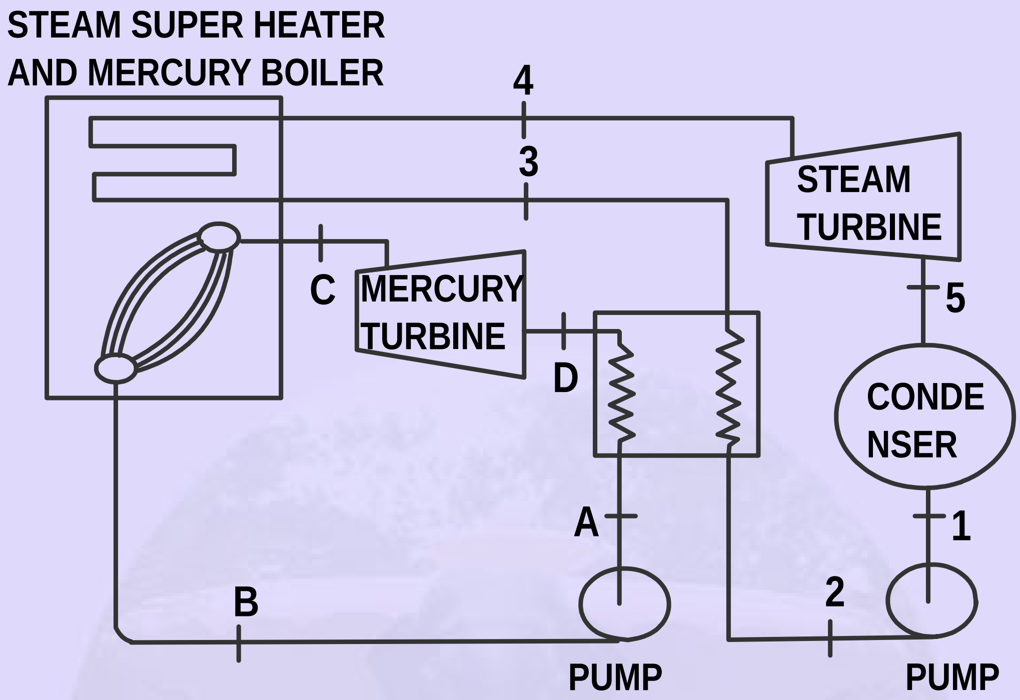
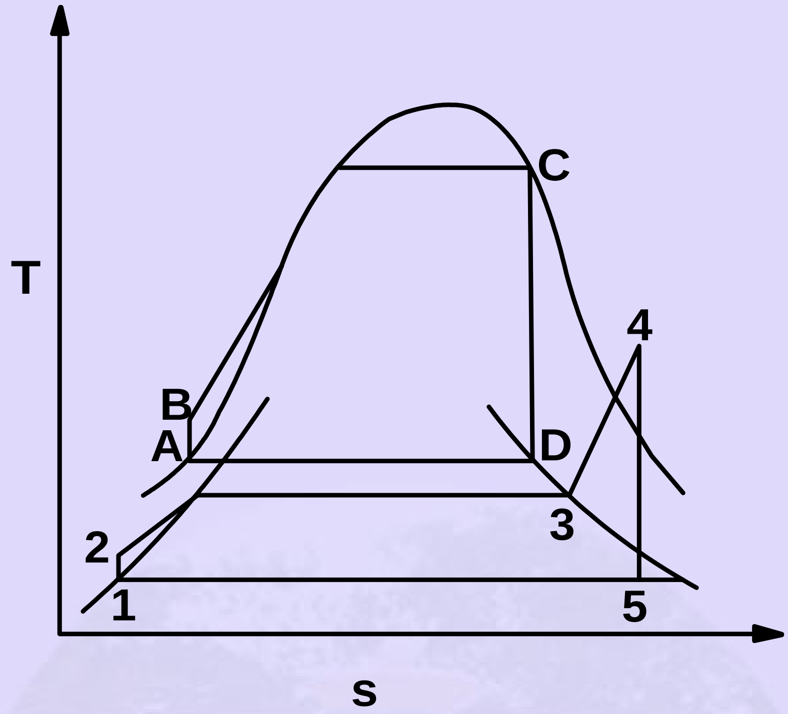
5.11 Mercury-Steam Binary Vapor Cycle:



(a)



(b)

Fig.5.11. Binary vapour power cycle

Above figure shows the schematic diagram of a mercury-steam binary cycle. The corresponding T-s diagram is also shown. There are two distinct circuits, one for mercury and the other for steam. Saturated mercury vapor from the mercury boiler at state C enters the mercury turbine, expands to state D, and is condensed at state A. The condensate is pumped back to the boiler by the mercury pump.

The heat rejected in the mercury condenser is used to vaporize water into steam at state 3. Thus, the mercury condenser also acts as the steam boiler. Note that there is a considerable temperature differential between condensing mercury and boiling water. Saturated steam is then superheated to state 4 as shown, expanded in the steam turbine to state 5 and then condensed. The mercury cycle is represented by A-B-C-D-A and the steam cycle by 1-2-3-4-5-1 on the T-s diagram.

Let x = mass of mercury per kg of steam.

Then,

$$x\left(h_D - h_A\right) = 1(h_3 - h_2) \approx (h_3 - h_1)$$

$$x = \frac{(h_3 - h_1)}{(h_D - h_A)}$$

$$\text{Net work done} = \left\{ \begin{matrix} \text{Hg turbine work} + \text{steam turbine work} \\ + \text{Hg pump work} + \text{steam pump work} \end{matrix} \right\}$$

$$w_{net} = x(h_C - h_D) + x(h_A - h_B) + (h_4 - h_5) + (h_1 - h_2)$$

Neglecting pump work:

$$w_{net} = x(h_C - h_D) + (h_4 - h_5)$$

Heat supplied per kg of steam $= x(h_C - h_B) + (h_4 - h_3) \approx x(h_C - h_A) + (h_4 - h_3)$

$$\eta_{th} = \left\{ \frac{x(h_C - h_D) + (h_4 - h_5)}{x(h_C - h_4) + (h_4 - h_3)} \right\}$$